Digital Logic Design and Microprocessors
EE313 Course Objectives
Spring 2004

Updated: 9 December 2003

LESSON #1. Course Introduction and Overview

- Understand the contents of the EE313 Course Policy Statement.
- Outline key topics in the EE313 syllabus.
- Distinguish between analog and digital representations.
- Understand the need for analog-to-digital converters (ADC) and digital-to-analog converters (DAC).
- List the advantages and disadvantages of a digital system.
- Identify the differences between serial and parallel transmission.

LESSON #2. Numbering Systems

- Convert numbers between hexadecimal, octal, binary, and decimal numbering systems.
- Identify advantages of the hexadecimal and octal systems.

LESSON #3. Codes

- Distinguish between Binary Coded Decimal (BCD) and straight binary codes.
- Explain the need for alphanumeric codes such as the ASCII Code.
- Describe the parity method for error detection.
- Calculate the parity (odd or even) of digital data.

LESSON #4. Logic Gates I

- Describe the operation of AND, OR, NAND, NOR gates.
- Construct truth tables for AND, OR, NAND, NOR gates.
- Explain the NOT Operation or Inverter Circuit.

LESSON #5. Logic Gates II

- Draw timing diagrams for the AND, OR, NAND, NOR logic circuit gates.
- Write boolean expressions for AND, OR, NAND, NOR gates and combinations of each.
- Create logic circuits using the AND, OR , and NOT gates.

LESSON #6. Boolean Algebra I

- Apply various rules of Boolean algebra to simplify complex logic circuits.

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- Apply DeMorgan's Theorem to simplify Boolean expressions.

LESSON #7. Boolean Algebra II

- Create a logic circuit represented by a Boolean expression using either NAND gates alone or NOR gates alone.
- Explain the advantages of constructing a logic circuit using alternate gate symbols verses using the standard AND, OR, NAND, NOR.
- Explain the concept of active HIGH and active LOW logic signals.
- Interpret logic circuits that use the new IEEE/ANSII standard symbols.

LESSON #8. Combinational Logic

- Express an arbitrary Boolean expression in Sum of Products form.
- Design a combinational logic circuit from a Sum of Products expression.
- Apply the Boolean Algebra theorems to simplify a logic circuit expression.
- Describe the steps involved in the complete design procedure for a logic circuit.

LESSON #9. Karnaugh Maps I

- Apply the Karnaugh Map process to simplify and design logic circuits.

LESSON #10. Karnaugh Maps II

- Explain the operation of both the Exclusive OR and Exclusive NOR circuits.
- Outline the operation of a Parity generator.
- Use the basic troubleshooting rules of digital systems.
- Deduce from measured results the faults of malfunctioning combinational logic circuits.
- Describe the fundamental idea of programmable logic.

LESSON #11. Flip-Flops I

- Construct and analyze the operation of a latch flip-flop made from NAND and NOR gates.
- Describe the difference between synchronous and asynchronous systems.
- Understand the S-C type of edge triggered flip-flop.
- Apply the flip-flop timing parameters specified by the manufacturer.

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LESSON #12. Flip-Flops II

- Understand the J-K and D types of edge triggered flip-flops.
- Apply the flip-flop timing parameters specified by the manufacturer.
- Draw the output timing waveforms of several types of flip-flops in response to a set of input signals.
- Describe the affects on asynchronous inputs to an edge-triggered flip-flop.
- Identify the various IEEE/ANSII flip-flop symbols.
- Identify the timing problems associated with flip-flop circuits.

LESSON #13. Flip-Flop Applications

- Apply flip-flops in a synchronization circuit.
- Describe how flip-flops are utilized in input sequence detection, data storage and transfer, and frequency-division circuits.

LESSON #14. Analyzing Sequential Circuits

- Analyze the operation of flip-flops in a sequential circuit.

LESSON #15. Digital Arithmetic

- Perform binary addition, subtraction, multiplication, and division on two binary numbers.
- Add and subtract hexadecimal numbers.
- Know the difference between binary addition and OR addition.
- Describe the advantages and disadvantages of three different systems for representing signed binary numbers.
- Manipulate signed binary numbers using the 2's-complement system.
- Understand the BCD adder circuit and the BCD addition process.

LESSON #16. Adders

- Describe the basic operation of an arithmetic logic unit (ALU).
- Design a parallel binary adder using full adders.
- Interpret the function of a full adder with look-ahead carry capability.
- Outline the operations performed by an arithmetic processing unit.
- Interpret the IEEE/ANSI symbol for a parallel adder.

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MIDTERM #1.

LESSON #17. Asynchronous Counters

- Identify the characteristics and operation of asynchronous counters.
- Explain MOD Counters with numbers < 2N.
- Identify IEEE/ANSI symbols used in IC counters and registers.
- Create an asynchronous down-counter.

LESSON #18. Synchronous Counters

- Identify the characteristics and operation of synchronous counters.
- Identify the various types of pre-settable counters.
- Explain the operation of multistage counters.
- Describe the effects of propagation delay on counter operation.

LESSON #19. Counter Design I

- Describe several types of schemes used to decode counters.
- Explain the operation of a BCD counter.

LESSON #20. Counter Design II

- Design an arbitrary-sequence synchronous counter.

LESSON #21. Decoders/ Encoders

- Apply decoders and encoders in various types of circuit applications.
- Explain the advantages and disadvantages of light-emitting diodes (LED) and liquid-crystal displays (LCD).

LESSON #22. Mux/DeMux

- Determine the operation of multiplexers and demultiplexers by analysis of circuit applications.
- Compare two binary numbers using the magnitude comparator circuit.

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LESSON #23. Data Busing

- Identify the precautions that must be considered when connecting digital circuits using the data-bus concept.

LESSON #24. Memories I

- Identify and correctly use the terminology associated with memory systems.
- Describe the difference between read/write memory and read-only memory.
- Distinguish the difference between volatile and non-volatile memory.
- Calculate the capacity of a memory device from its inputs and outputs.
- Outline the steps that occur when the CPU reads from or writes to memory.
- Distinguish among the various types of ROMs and describe some common applications.
- Describe the architecture of the basic types of programmable logic devices.

LESSON #25. Memories II

- Explain the organization and operation of static and dynamic RAMs.
- Calculate the capacity of cascading memory.
- Distinguish between the various types of RAM and describe their applications.
- Compare the relative advantages and disadvantages of EPROMs, EEPROMs, and Flash memory.

LESSON #26. Microcomputer Organization

- Describe the function and operation of each one of the five basic elements of a computer.
- Explain the difference between the different types of computers.
- Describe the various cycles associated with the execution of a machine-language program.
- List the major functions performed by a microprocessor.
- Describe the different types of computer words.

MIDTERM #2.

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LESSON #27. Program Execution

- Describe the various cycles associated with the execution of a machine language program.
- Explain the fetch and execute cycles of a machine language program.

LESSON #28. Microcontroller Organization

- Describe the various elements of a micro-controller.
- Explain the difference between micro-controllers and microprocessors.
- List the major functions performed by a micro-controller.

LESSON #29. PIC 16F84/ Addressing Modes

- Describe the architecture of the PIC16F84 micro-controller.
- Describe the various addressing modes for the PIC16F84.

LESSON #30. Instruction Set I/ Flow Control

- Explain flow control for the PIC16F84.
- Interpret the instructions for the PIC16F84 and use these instructions in writing a program to perform a simple logic function.

LESSON #31. Instruction Set II

- Identify the elements in the PIC16F84 instruction set.

LESSON #32. Basic Operations/ Math

- Perform math operations using the PIC16F84 instruction set.

LESSON #33. Data Tables/ Applications

- Perform table look-up functions using the PIC16F84 instruction set.

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LESSON #34. PIC Peripherals/ Interrupts

- List the family of peripherals that can be controlled by the PIC16F84.
- Identify and explain the operation of the interrupt scheme for the PIC16F84.

LESSON #35. Interfacing with the Analog World

- Understand the theory of operation and the circuit limitations of several types of digital-to-analog converters (DAC).
- Compare the advantages and disadvantages among the digital-ramp. analog-to-digital converter (ADC), successive-approximation ADC, and flash ADC.
- Analyze the process by which a computer in conjunction with an ADC digitizes an analog signal and then reconstructs that analog signal from the digital data.
- Understand the need for using sample-and-hold circuits in conjunction with ADCs.
- Describe the operation of an analog mulitplexing system.
- Understand the basic concepts of digital signal processing.

LESSON #36. IC Logic Families and Specifications

- Identify the various code designations of the different IC logic Families.

LESSON #37. Micro-controller Families

- Understand the differences between micro-controller families.

LESSON #38. Integrated Circuit (IC) Manufacturing

- Understand the processes used in the manufacture of integrated circuits.